Appendix B

Biosolids Use and Disposal in the United States and the World

Uses of Biosolids

Land Reclamation	• Reclamation and revegetation of minelands (metal, sand/gravel, coal) in combination with other residuals • Remediation of contaminated sites • Restoration and development of water features (wetland enhancement, shoreline revegetation) • Component of topsoil in landfill closures (for vegetation and methane mitigation) • Component in topsoil manufacturing • Bioremediation (with iron-rich biosolids compost) of urban and suburban contaminated sites
Landscaping / Horticulture	• Feedstock in compost • Revegetation of fields, rights of way to exclude woody or nuisance species like Scots broom • Enhancement of lawns, parks, sports fields • Potting and mulch mixes • Custom soil products • Garden fertilizer (heat-dried pellets) • Sod production • Erosion control (compost berms) • Highway right-of-way revegetation • Incinerator ash for phosphorus and liming value in soil mixes
Low Impact Development	• Biofiltration of stormwater flow • Green roofs
Agriculture	• Crop fertilization • Amending agricultural soil • Growing biofuel crops • Controlling soil losses from wind
Rangeland	• Forage improvement
Forestry	• Forest fertilization • Intensive silviculture for fiber crops (hybrid poplar)
Industrial Processes	• Making brick or other building materials • Making glass aggregate used in tiles and pavement • Daily landfill cover
Energy Recovery / Biofuel	• Biogas from digestion • Incineration with heat recovery and/or electricity generation • Dry product supplement for coal in cement kilns • Gasification, pyrolysis, and other developing hi-tech energy production options

Uses that King County currently practices or has demonstrated.

Taken from: Biosolids Seminar, Water Environment Association of Ontario, October 1, 2007. Compiled by Ned Beecher (North East Biosolids and Residuals Association, Marc Hébert (Ministèrre du development durable, de l'environnement et des parcs, Quebec, Canada), and Mark Teshima (Sylvis Environmental, British Columbia, Canada).

Biosolids Use in the United States

The most recent national surveys of wastewater treatment utilities use 2004 data, which shows about 16,500 facilities produce biosolids in the U.S. More than 90% of the biosolids generated, however, comes from only 3,300 of these utilities. These utilities represent King County's peer group. The information in this summary includes data from this group.

Data compiled from states, the US EPA, and other sources indicate that 7,180,000 dry tons of biosolids were produced in 2004. King County produced about 26,000 dry tons, making the County 0.36% of the national total.

The following categories were used in the national survey to give a general picture of national practices. Graphs on the following pages provide a quick overview of these categories.

- Beneficial use or disposal
- Types of beneficial use
- Types of disposal
- Biosolids quality, Class A or B

Beneficial use or disposal?

In the US, 55% of biosolids produced were applied to soils (beneficial use) and 45% were landfilled or incinerated (disposal). To biosolids managers in the Pacific Northwest, the amount disposed nationally is surprisingly high. In the Pacific Northwest (WA, OR, ID, BC), the beneficial use rate averages 88%.

It's important to note that the definition of beneficial use in these national surveys is still the traditional one: biosolids applied to soils for agronomic, silvicultural, or land restoration purposes. Disposal includes landfilling, surface disposal, and incineration. *No information collected to date distinguishes between incineration with or without energy capture.* As more utilities seek energy benefits from biosolids, a broader definition of beneficial use will no doubt become established. At this time, however, the Washington State Department of Ecology also recognizes only soil-building uses as beneficial uses.

Types of beneficial use

Agriculture is, by far, the most-practiced beneficial use of biosolids in the United States. It represents 74% of the beneficial use category. The next largest use, 22%, is distribution of Class A Exceptional Quality products such as biosolids compost and heat-dried pellets. Reclamation at 3% and forestry at 1% are uncommon practices.

Types of disposal

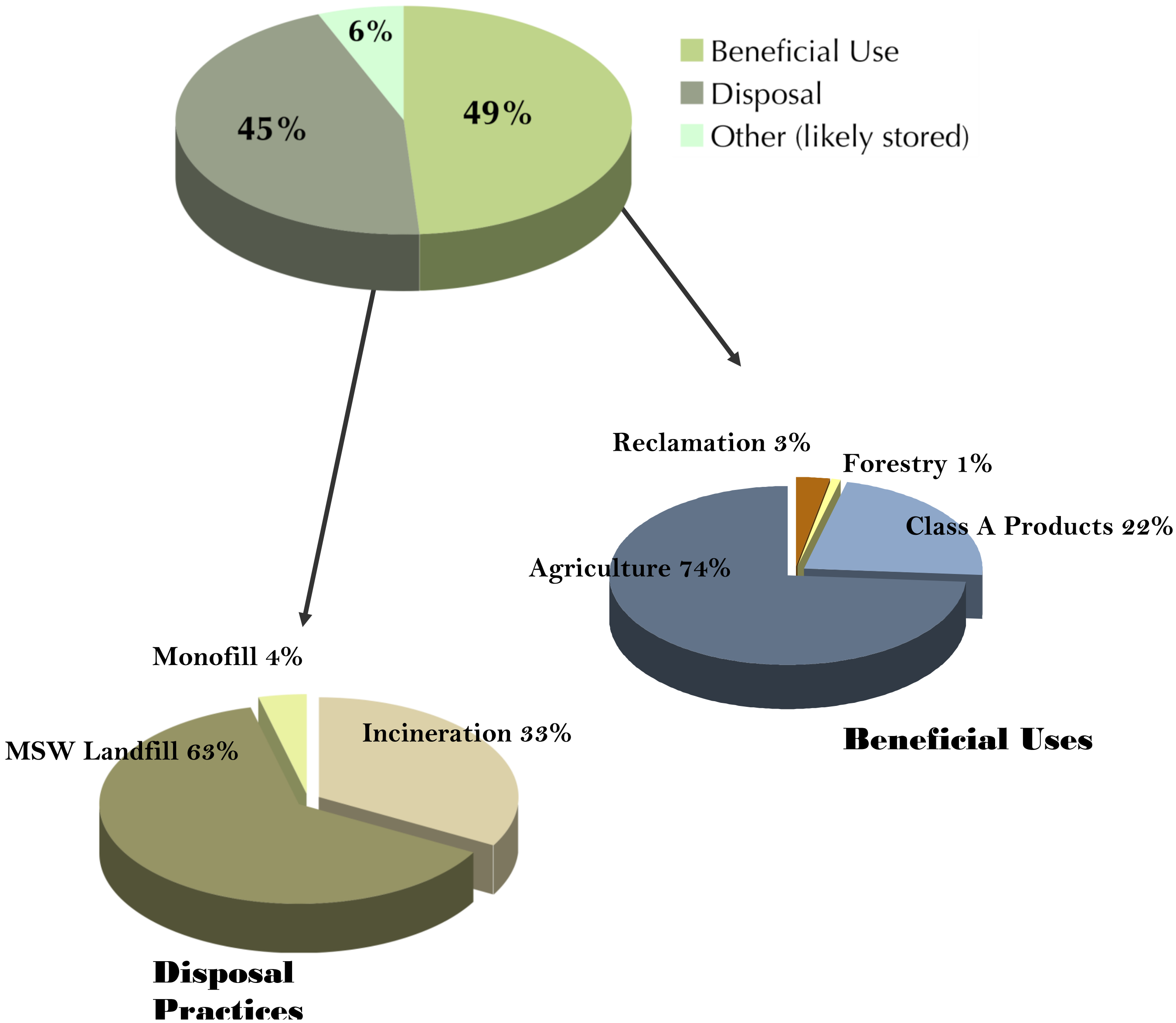
Landfilling with municipal solid waste is the most common disposal practice, at 63% of the disposal total. Incineration is the second most common (33%), particularly in densely populated states such as Connecticut and Rhode Island. Other cities also incinerate biosolids: Cleveland, Indianapolis, and Anchorage. In Washington state, Edmonds, Bellingham, and Vancouver incinerate biosolids but do not capture energy from the combustion.

Biosolids quality: Class A or B?

National data on biosolids quality is incomplete. 43% of survey respondents did not specify whether their biosolids was Class A or B. This is likely because biosolids quality does not matter when biosolids are being landfilled or incinerated. Of the total reports, 34% specified Class B and 23% Class A.

Summary of Biosolids Use and Disposal

2004 US Totals



Source: A National Biosolids Regulation, Quality, End Use & Disposal Survey, North East Biosolids and Residuals Association, 2007.

Examples of Practices at Large US Wastewater Utilities

Hampton Roads, VA

- Nutri-Green® compost: biosolids + recycled paper products and woodchips
- Agricultural land application since 1981
- Incinerators at some plants; ash recycled into cement, potting soil mixes
- R&D at their Progress Farm with Virginia Tech U. and Virginia Coop Extension
- Pilot project to dry biosolids

City of Los Angeles, CA 650 tons/day

- TOPGRO® compost with zoodoo, biosolids, park greenery debris, 20-30 tons/day
- Agriculture with Class A dewatered biosolids at Green Acres Farm in Kern County, CA. Grow non-food chain crops of wheat, corn, alfalfa, milo, and rye; used as feedstock at local dairies. Successfully defended against lawsuit from Kern County against imported biosolids. Being appealed by Kern Cty.
- Agriculture in Arizona 50 tons/day
- Deep well injection of biosolids slurry into sand at depths of 3,800-5,300 feet. Produces CO_2, which is sequestered, and methane, which is captured and used to generate electricity. Using 400 tons/day of biosolids.

Orange County, CA

- Compost being actively promoted. 98% of those residents surveyed said they would use it. Takes 1/3 of biosolids @ $70/wt, not including haul.
- Agriculture on Tule Ranch, Arizona. Takes approx. 1/3.
- EnerTech's SlurryCarb® process to produce renewable fuel/pellet. Takes approx. 1/3 at special start-up price of $80/wt, not including haul.

Los Angeles County, CA 1,500 tons/day

- Using digester gas to make electricity
- Composting
- EnerTech's SlurryCarb® process to produce renewable fuel/pellet.
- Long-range plan calls for more composting, with agricultural waste and urban green waste

Example of a Program Similar in Size to King County

Denver, CO 350 tons/day

- Using digester gas to make electricity 4 MW/day
- Owns truck fleet and utility employees maintain it
- Agricultural application of METROGRO® cake on its own farm and private farmland
- METROGRO® compost produced by the district (deliveries during inclement weather or poor field conditions)
- Contract with private composter as a backup
- Thermal drying may be future option

Biosolids Use Throughout the World

Global atlases of biosolids use and disposal were published in 1996 and 2008. These references provide an overview of wastewater treatment and solids management in low income, middle income, and the most developed countries in the world. Division of the world into these three categories allows King County to compare its biosolids management options to those being used by countries at a similar level of development.

The world's countries can be divided into these general categories of wastewater management:

I. <u>Lack of basic sanitation: focus is on avoiding human waste or rudimentary collection.</u> Forty percent of the world's population lacks basic sanitation. This includes sub-Saharan Africa, and parts of Asia, Central and South America.

II. <u>Developing treatment systems and regulations: focus on public health, not environment.</u> These countries include eastern Europe, the Middle East, China and Russia, Mexico and a few countries in Africa and South America. Levels of treatment vary throughout these countries and the predominant solids treatment is burying/landfilling.

III. <u>Effective wastewater treatment and layers of regulations in place: focus on public health, environment, and sustainability of management programs</u>. In western Europe, North America, Japan, Australia and New Zealand, wastewater is treated to secondary and tertiary levels. Biosolids technologies and regulations are complex and much effort is devoted to improving efficiency and reducing negative impacts to the environment.

Different countries, different approaches

Among Level III countries with advanced wastewater management, countries can take very different approaches depending on their values or their local circumstances and opportunities. For example, western Europe and the United States both have decades of research on biosolids and its behavior and its risks and benefits. The US has adopted the concept of risk assessment and standards that are based on demonstrable effects. In contrast, the EU has adopted a precautionary approach or a "no-degradation to soils" approach in setting numerical limits on biosolids constituents. Because of this pressure to reduce contaminants in biosolids, the EU is ahead of the US in eliminating certain chemicals from consumer products, such as PBDEs (flame retardants).

Even within the EU, circumstances of each country will determine the most appropriate use of biosolids. Countries with high population densities or where farmland is already fertilized with manure will look for uses other than land application of dewatered, bulk biosolids. Switzerland and some Austrian states have an overabundance of manures and have banned the use of biosolids on soils. The Netherlands does not land apply; it composts biosolids then exports it to be used as a biofuel at power stations in Germany.

Land application is common in England, France, Spain, Czech Republic, Bulgaria, Slovakia, Norway, Australia, New Zealand and growing steadily in middle income countries. Land application, once dominant, is diminishing in favor of incineration in Austria and Germany.

Two countries with completely different approaches are Norway and Japan.
Japan has a goal of 100% energy independence at its wastewater treatment facilities, leading it to maximize energy recovery from solids and to supplement with other local organic wastes.
Because of Japan's population density and mountainous terrain, it would require 11% of the country's agricultural lands to manage its biosolids. (In the US, the comparable number is 0.3% of our agricultural acreage.) Nevertheless, the amount of biosolids used in agriculture has remained steady

at about 14% of the country's total production. Japan's predominant beneficial use is incinerator ash, used as soil additive, concrete filler, bricks, and slag for backfilling and a sub-base for road construction. Japan is driven to achieve more energy independence, and energy capture from biosolids is part of the national strategy.

Norway uses more than 90% of its biosolids as a soil amendment: 1/3 goes to parks, sports fields, roadsides, landfill top cover as part of a soil blend and 2/3 goes to agricultural land as a fertilizer. Norway has implemented stringent standards for biosolids quality and emphasized odor control. Norwegian regulations for biosolids are stricter than most other countries, and it has the highest rate of beneficial use in soils.

Germany has traditionally used its biosolids in agriculture, but is trending toward more incineration, with and without energy capture. As of 2003, 57% of its production was used in agriculture and landscaping, with 34% incinerated and the rest in storage or landfilled. The introduction of stricter quality standards for land application led many utilities to conclude that incineration was a more reliable long-term management option.

Estimates of biosolids use and disposal options in 2010 practiced by the fifteen original members of the European Union are as follows:

- Agriculture 45%
- Thermal Destruction 23%
- Landfilling 18%
- Composting 7%
- Other 7%

With the addition of 12 new members to the EU, total production of biosolids is likely to rise by about 25%, with a bias towards use on land, particularly in agriculture.

Innovative practices

Authors of the 2008 Global Atlas of Biosolids Management recognize the following "innovative and notable" practices worldwide:

- Reclamation of damage lands in British Columbia and Colorado
- Fertilization of fast-growing poplars and other fiber crops
- Fertilization of biofuel crops; "King County, WA is considered a leader in this."
- Pyrolysis and gasification for direct conversion to fuels
- Co-digestion with local organic materials to boost methane production
- Technologies that lyse cells followed by thermophilic digestion to boost methane production
- Extraction of other elements from biosolids, such as phosphorus

General conclusions

- Landfilling is widely recognized as less desirable and being discouraged around the world. The EU is attempting to phase out landfilling of all organic materials. From 1996-2010, landfilling as an option decreased from 42% to 18% of the EU's biosolids.
- Land application is growing throughout the world, as middle income countries find it suitable for their economies and high income countries practice it wherever suitable land is available (grew from 36% to 45% of biosolids treated in EU from 1996-2010).
- Incineration is becoming more common in large, densely populated areas. Japan incinerates 70% of its solids. In the Netherlands and Germany, rates are 58% and 34% respectively.

Source: Global Atlas of Excreta, Wastewater Sludge, and Biosolids Management, United Nations-Habitat Program, 2008.